

APPENDIX J

Johnson & Ettinger Indoor Air Model

HWMU 167 Indoor Air from Groundwater

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

GW-SCREEN
Version 2.3; 03/01

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

ENTER	YES	ENTER	X
Chemical CAS No. (numbers only, no dashes)	Initial groundwater conc., C_w ($\mu\text{g/L}$)	Chemical	
71432	0.4	Benzene	Benzene
108383	1.3	m-Xylene	M,p-xylene
95476	0.4	o-Xylene	O-xylene
108883	4.8	Toluene	Toluene

MORE
↓

ENTER	ENTER	ENTER	ENTER
Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	Depth below grade to water table, L_{WT} (cm)	SCS soil type directly above water table	Average soil/ groundwater temperature, T_S (°C)
15	213	C	11

MORE
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ENTER	ENTER	ENTER	ENTER	ENTER
Vadose zone SCS soil type (used to estimate soil vapor permeability)	User-defined vadose zone soil vapor permeability, k_v (cm^2)	Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	Vadose zone soil total porosity, n^V (unitless)	Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
C		1.5	0.43	0.3

Diffusivity in air, D _a (cm ² /s)	Diffusivity in water, D _w (cm ² /s)	Henry's law constant at reference temperature, H (atm-m ³ /mol)	Henry's law constant reference temperature, T _R (°C)	Enthalpy of vaporization at the normal boiling point, ΔH _{v,b} (cal/mol)	Normal boiling point, T _B (°K)	Critical temperature, T _C (°K)	Organic carbon partition coefficient, K _{oc} (cm ³ /g)	Pure component water solubility, S (mg/L)
8.80E-02	9.80E-06	5.56E-03	25	7,342	353.24	562.16	5.89E+01	1.75E+03
7.00E-02	7.80E-06	7.34E-03	25	8,523	412.27	617.05	4.07E+02	1.61E+02
8.70E-02	1.00E-05	5.20E-03	25	8,661	417.60	630.30	3.63E+02	1.78E+02
8.70E-02	8.60E-06	6.63E-03	25	7,930	383.78	591.79	1.82E+02	5.26E+02
END								

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Source-building separation,	Vadose zone soil air-filled porosity,	Vadose zone effective total fluid saturation,	Vadose zone soil intrinsic permeability,	Vadose zone soil relative air permeability,	Vadose zone soil effective vapor permeability,	Thickness of capillary zone,	Total porosity in capillary zone,	Air-filled porosity in capillary zone,	Water-filled porosity in capillary zone,	Floor-wall seam perimeter,
L_T (cm)	θ_a^V (cm^3/cm^3)	S_{te} (cm^3/cm^3)	k_i (cm^2)	k_{rg} (cm^2)	k_v (cm^2)	L_{cz} (cm)	n_{cz} (cm^3/cm^3)	$\theta_{a,cz}$ (cm^3/cm^3)	$\theta_{w,cz}$ (cm^3/cm^3)	X_{crack} (cm)

198	0.130	0.608	2.26E-09	0.604	1.37E-09	81.52	0.43	0.018	0.412	3,844
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Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm- m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} ($\text{g}/\text{cm}\cdot\text{s}$)	Vadose zone effective diffusion coefficient, $D_{eff,v}$ (cm^2/s)	Capillary zone effective diffusion coefficient, $D_{eff,cz}$ (cm^2/s)	Total overall effective diffusion coefficient, $D_{eff,T}$ (cm^2/s)
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5.63E+04	9.24E+05	4.16E-04	15	8,112	2.83E-03	1.21E-01	1.76E-04	5.41E-04	2.35E-05	5.38E-05	Benzene
				10,243	3.13E-03	1.34E-01			4.30E-04	1.70E-05	m-Xylene
				10,393	2.19E-03	9.40E-02			5.38E-04	3.08E-05	o-Xylene
				9,144	3.10E-03	1.33E-01			5.34E-04	1.90E-05	Toluene

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu\text{g}/\text{m}^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu\text{g}/\text{m}^3$)
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198	15	4.86E+01	0.10	1.32E+00	5.41E-04	3.84E+02	1.96E+41	3.74E-06	1.82E-04	Benzene
		1.75E+02			4.30E-04		9.58E+51	2.84E-06	4.96E-04	m-Xylene
		3.76E+01			5.38E-04		3.65E+41	4.59E-06	1.73E-04	o-Xylene
		6.38E+02			5.34E-04		7.61E+41	3.15E-06	2.01E-03	Toluene

HWMU 167 Indoor Air from Soil

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-SCREEN
Version 2.3; 03/01

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

ENTER

Chemical
CAS No.
(numbers only,
no dashes)

ENTER

initial soil
conc.,
 C_R
($\mu\text{g}/\text{kg}$)

YES

X

Chemical

67641

29

Acetone

75092

28.5

Methylene chloride

MORE
↓

ENTER
Depth
below grade
to bottom
of enclosed
space floor,
 L_F
(15 or 200 cm)

ENTER
Depth below
grade to top
of contamination,
 L_t
(cm)

ENTER
Average
soil
temperature,
 T_S
(°C)

ENTER
Vadose zone
SCS
soil type
(used to estimate
soil vapor
permeability)

ENTER
User-defined
vadose zone
soil vapor
permeability,
 k_v
(cm^2)

OR

15

15

11

S

Enter correct SCS soil type, or user-defined permeability.

MORE
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ENTER
Vadose zone
soil dry
bulk density,
 ρ_b^A
(g/cm^3)

ENTER
Vadose zone
soil total
porosity,
 n^V
(unitless)

ENTER
Vadose zone
soil water-filled
porosity,
 θ_w^V
(cm^3/cm^3)

ENTER
Vadose zone
soil organic
carbon fraction,
 f_{oc}^V
(unitless)

1.5

0.43

0.3

0.02

HWMU 167 Indoor Air from Soil

SL-SCREEN
Version 2.3; 03/01

Diffusivity in air, D _a (cm ² /s)	Diffusivity in water, D _w (cm ² /s)	Henry's law constant at reference temperature, H (atm-m ³ /mol)	Henry's law constant reference temperature, T _R (°C)	Enthalpy of vaporization at the normal boiling point, ΔH _{v,b} (cal/mol)	Normal boiling point, T _B (°K)	Critical temperature, T _c (°K)	Organic carbon partition coefficient, K _{oc} (cm ³ /g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF (μg/m ³) ⁻¹	Reference conc., RfC (mg/m ³)	Physical state at soil temperature, (S,L,G)	COMPOUND
1.24E-01	1.14E-05	3.88E-05	25	6,955	329.20	508.10	5.75E-01	1.00E+06	0.0E+00	3.5E-01	L	Acetone
1.01E-01	1.17E-05	2.19E-03	25	6,706	313.00	510.00	1.17E+01	1.30E+04	4.7E-07	3.0E+00	L	Methylene chloride
END												

HWMU 167 Indoor Air from Soil

Source-building separation,	Vadose zone soil air-filled porosity,	Vadose zone effective total fluid saturation,	Vadose zone soil intrinsic permeability,	Vadose zone soil relative air permeability,	Vadose zone soil effective vapor permeability,	Floor-wall seam perimeter,	Initial soil concentration used,	Bldg. ventilation rate,	SL-SCREEN Version 2.3; 03/01
L_T (cm)	θ_a^V (cm ³ /cm ³)	S_{te} (cm ³ /cm ³)	k_i (cm ²)	k_{rg} (cm ²)	k_v (cm ²)	X_{crack} (cm)	C_R (μg/kg)	$Q_{building}$ (cm ³ /s)	

1	0.130	0.655	9.94E-08	0.203	2.02E-08	3,844	2.90E+01	5.63E+04	Acetone Methylene chloride
							2.85E+01		

Area of enclosed space below grade,	Crack-to-total area ratio,	Crack depth below grade,	Enthalpy of vaporization at ave. soil temperature,	Henry's law constant at ave. soil temperature,	Henry's law constant at ave. soil temperature,	Vapor viscosity at ave. soil temperature,	Vadose zone effective diffusion coefficient,	Diffusion path length,
A_B (cm ²)	η (unitless)	Z_{crack} (cm)	$\Delta H_{v,TS}$ (cal/mol)	H_{TS} (atm-m ³ /mol)	H'_{TS} (unitless)	μ_{TS} (g/cm-s)	$D_{eff,v}^*$ (cm ² /s)	L_d (cm)

9.24E+05	4.16E-04	15	7,547	2.07E-05	8.88E-04	1.76E-04	2.01E-03	1
			7,023	1.22E-03	5.24E-02		6.34E-04	

Convection path length,	Soil-water partition coefficient,	Source vapor conc.,	Crack radius,	Average vapor flow rate into bldg.,	Crack effective diffusion coefficient,	Area of crack,	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$	Infinite source indoor attenuation coefficient, α	Infinite source bldg. conc., $C_{building}$
L_p (cm)	K_d (cm ³ /g)	C_{source} (μg/m ³)	r_{crack} (cm)	Q_{soil} (cm ³ /s)	D_{crack} (cm ² /s)	A_{crack} (cm ²)	$(unitless)$	$(unitless)$	$(μg/m^3)$

15	1.15E-02	1.22E+02	0.10	1.94E+01	2.01E-03	3.84E+02	1.02E+164	3.42E-04	4.16E-02	Acetone
	2.34E-01	3.40E+03			6.34E-04		#NUM!	3.34E-04	1.14E+00	Methylene chloride